

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY


(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 20 MAR 2006

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Applicant's or agent's file reference 11321-P086WO	FOR FURTHER ACTION		See Form PCT/PEA/416
International application No. PCT/US2005/009677	International filing date (day/month/year) 24.03.2005	Priority date (day/month/year) 25.03.2004	
International Patent Classification (IPC) or national classification and IPC C01B31/02			
Applicant WILLIAM MARSH RICE UNIVERSITY et al.			
1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36. 2. This REPORT consists of a total of 6 sheets, including this cover sheet. 3. This report is also accompanied by ANNEXES, comprising: a. <input type="checkbox"/> sent to the applicant and to the International Bureau) a total of sheets, as follows: <input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions). <input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box. b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).			
4. This report contains indications relating to the following items: <input checked="" type="checkbox"/> Box No. I Basis of the opinion <input type="checkbox"/> Box No. II Priority <input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability <input type="checkbox"/> Box No. IV Lack of unity of invention <input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement <input checked="" type="checkbox"/> Box No. VI Certain documents cited <input type="checkbox"/> Box No. VII Certain defects in the international application <input checked="" type="checkbox"/> Box No. VIII Certain observations on the international application			
Date of submission of the demand 10.10.2005	Date of completion of this report 17.03.2006		
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Marucci, A Telephone No. +49 89 2399-		



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Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language, which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-17 as originally filed

Claims, Numbers

1-28 as originally filed

Drawings, Sheets

1/11-11/11 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing *(specify)*:
 - ☐ any table(s) related to sequence listing *(specify)*:
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing *(specify)*:
 - ☐ any table(s) related to sequence listing *(specify)*:

* If item 4 applies, some or all of these sheets may be marked "superseded."

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Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-28
	No: Claims	
Inventive step (IS)	Yes: Claims	
	No: Claims	1-28
Industrial applicability (IA)	Yes: Claims	1-28
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rule 70.10)

and /or

2. Non-written disclosures (Rule 70.9)

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V.

1 Reference is made to the following documents:

- D1 : J.L. BAHR AND J. M. TOUR: "Highly functionalized carbon nanotubes using in situ generated diazonium compounds" CHEM. MATER., vol. 13, 24 October 2001 (2001-10-24), pages 3823-3824, XP002350421
- D2 : V.A. DAVIS ET AL: "Phase behavior and rheology of SWNTs in superacids" MACROMOLECULES, vol. 37, 9 December 2003 (2003-12-09), pages 154-160, XP002350422
- D3: C.A. DYKE AND J.M.TOUR: "Solvent-free functionalization of carbon nanotubes" J. AM. CHEM. SOC., vol. 125, 2003, pages 1156-1157, XP002350420
- D4: T. V. SREEKUMAR ET AL: "Single-wall carbon nanotube films" CHEM. MATER., vol. 15, 4 December 2003 (2003-12-04), pages 175-178, XP002350423

2 Inventive step:

- 2.1 Document D1 discloses a method for functionalizing carbon nanotubes by preparing a suspension of purified SWNTs in 1,2-dichlorobenzene and by reacting it with a mixture of an aniline derivative with isoamyl nitrite (page 3823, column 2, lines 3-23; figure 1). The preparation in situ of diazonium from the aniline derivative and the isoamyl nitrite was found to be an effective means of functionalization (page 3824, last sentence before the "Acknowledgement").
- 2.2.1 Document D1, which is considered to represent the most relevant state of the art, discloses a method from which the subject-matter of independent claim 1 differs in that the carbon nanotubes to be functionalised are dispersed in an acidic medium.
- 2.2.2 The problem to be solved by the present invention may therefore be regarded as enhancing the degree of functionalization of the product by increasing the de-roping of the nanotube bundles through a better dispersion of the carbon nanotubes in the reacting solution.

2.2.3 In view of D2 the solution proposed in claim 1 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

Document D2 reports a method for dispersing SWNTs at concentrations up to 10 wt% in superacids ("Introduction" and "Experimental methods"). The interaction between the superacid and the SWNTs is said to overcome the wall-wall van der Waal interactions in the bundles and to disperse a higher concentration of nanotubes than the usual surfactant solutions.

2.2.4 A man skilled in the art willing to solve the problem posed, would therefore apply the teaching of document D2 to the method disclosed in D1 without exercise of any inventive skills. The proposed solution in independent claim 1 thus cannot be considered inventive (Article 33(3) PCT).

2.3 The same reasoning as given for claim 1 will apply mutatis mutandis for the subject-matter of claim 16.

Therefore claim 16 also does not meet the requirements of the PCT in respect of inventive step (Article 33 (3) PCT).

2.4 The attention of the applicant is drawn to the fact that also documents D3 and D4 are relevant for the inventive step. Document D3 stresses the severe limitation of functionalization processes performed in solution due to the extraordinary amount of solvent needed for dispersing the nanotubes (page 1156, column 1, lines 4-13) and reports a method for a solvent-free functionalization of carbon nanotubes with a substituted aniline together with isoamyl nitrite (page 1156, column 1). Document D4 discloses a method for dispersing carbon nanotubes in an oleum solution ("Experimental section").

2.5 **DEPENDENT CLAIMS 2-15, 17-28**

Dependent claims 2-15, 17-28 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (Article 33(2) and (3) PCT).

3 Claim 16 comprises all the features of claim 1 and is therefore not appropriately

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(SEPARATE SHEET)**

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formulated as a claim dependent on the latter (Rule 6.4 PCT).

Re Item VIII.

- 4 The vague and imprecise statement in the description on page 14 ([0054]) and on page 17 ([0068]) concerning the "spirit of the present invention" implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them.